Specification for the Reinstatement of Openings in Roads 2003 (SROR)
Appendix A9 Trial

Approval of SMR as C2 Non Flowable Structural Material for Reinstatements (C2 NFSMR) for use in utility Reinstatements in accordance with SROR 2003

Trial Start Date: 06 November 2012
Trial End Date: 30 November 2014
Date of Issue of Report: 06 March 2015

CONTENTS

1. Introduction

1.1 The reinstatement of utility excavations in the road is governed by a Code of Practice issued the Scottish Executive under Section 130 of the New Roads and Street Works Act 1991 (NRSWA). The latest (third) edition of this Code of Practice, known as the Specification for the Reinstatement of Openings in the Road (SROR) came into force in October 2003. The SROR sets down the minimum standards for the reinstatement of openings made by Utility Companies in the course of managing their plant buried under the Road. This report is written on the understanding that readers will have a working knowledge of the SROR (third edition) and particularly Appendix 9 of this.

1.2 The SROR (third edition) sets down requirements for a range of standard reinstatement solutions, detailing options for the materials to be used and the workmanship necessary to achieve a satisfactory reinstatement.

1.3 Within the SROR, materials are generally specified in accordance with British or European standards but Appendix A9 sets out end performance criteria to enable the development and use of Alternative Reinstatements Materials (ARMs). ARMS may fall into one of two general categories;

1.3.1 Stabilised Materials for Fills (SMFs), characterised by bearing capacity and aimed at use in the lower layers of reinstatements and

1.3.2 Structural Materials for Reinstatements (SMRs) characterised by compressive strength and potentially of use up to the Base layer in roads and the Binder Course in footways as set down in Table A9.1 of SROR. SMRs may be either Flowable (FSMR) or Non-Flowable (NFSMR) in nature. Significant freedom is available regarding the production of SMRs, however their classification and thereby restrictions on where they may be used in any particular reinstatement is governed by their crushing strength at 28days, this can be either;

C3/4 – Minimum C3/4 N/mm2, maximum C9/12 N/mm2 or
C1.5/2 – Minimum C1.5/2 M/mm2, maximum C9/12 N/mm2

1.4 This report details the evaluation of the "**SMR Eco Proprietary Binder**" product as a Class C1.5/2 Non-Flowable SMR (NFSMR) in accordance with Appendix A9 of SROR.

2. Parties Involved

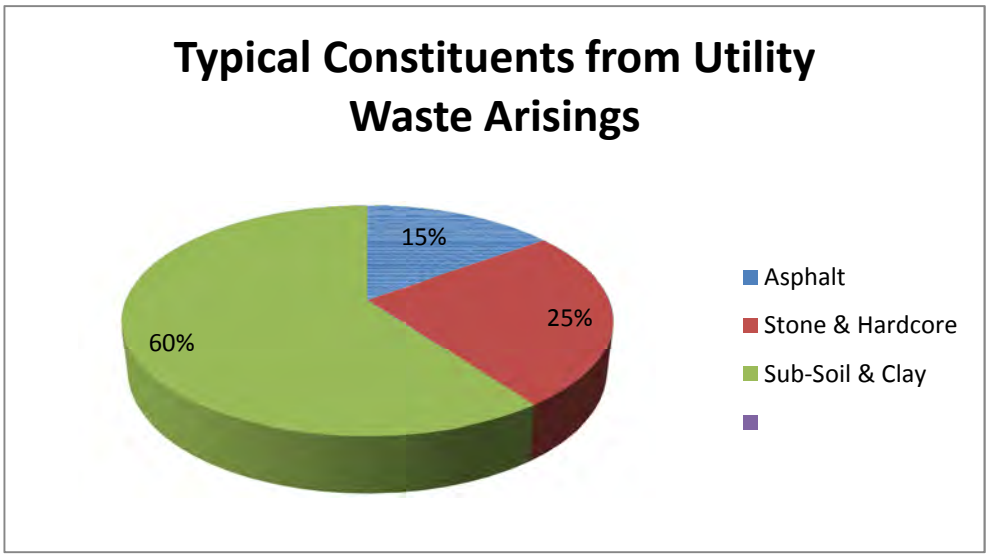
2.1 This trial has been undertaken by Scottish Water and Glasgow City Council with technical support provided by SMR Eco Proprietary Binder & QA Process Supplier: METSSL Ltd.

3. Drivers & Needs for C2 NFSMR produced with the SMR Eco Binder

3.1 The utility industry is currently faced with a number of challenges. In particular there is the acute need to reduce waste arisings sent to landfill, reduce the carbon footprint and produce high quality reinstatements in the footpaths and carriageways. The SMR Eco Proprietary Binder has been developed to help fulfil these needs:

3.2 Landfill Diversion

3.2.1 The SMR Eco Proprietary Binder has been developed to help achieve a much higher recovery rate on utility waste that traditional recycling solutions and materials. Traditional recycling is typically only able to recover the granular materials from utility trench arisings i.e. asphalt, hardcore and stone. This typically comprises of 45% of the utility waste, with the remaining 55% (typically sub-soil and clay) going for disposal. The SMR Eco proprietary binder enables the recovery of the sub-soil and clay element of utility waste in addition to the asphalt, hardcore and stone. This vastly increases the recovery rate on utility waste.



3.3 Carbon Footprint Reduction

3.3.1 By using SMR Eco the carbon footprint is reduced in a number ways:

1. Reduced Lorry movements from not having to send the sub-soil & clay segment of utility waste to landfill.
2. Elimination of the need for primary aggregates as the utility waste is recovered and used back in the utility trench instead of primary aggregates.
3. Reduced remediation costs due to the high performance/stiffness of the C2 NFSMR compared to traditional primary and secondary unbound aggregates e.g. Type 1 803.
4. Reduced lorry movements to and from the utility site if a Mobile Batching plant is used on-site to produce the C2 NFSMR
5. Reduced lorry movements by using a One-Stop-Shop Hub Recycling Facility. These are set up in logistically suitable locations to offer a 'One-Stop-Shop' solution to the utility industry. This is a solution where utility companies and their contractors are able to legally tip their waste and in return pick up the backfill products that they require. It is important to note that all the backfill products purchased from these facilities are produced under the *WRAP Quality Protocol for the Production of Recycled Aggregates*. It is very important that recycled backfill products are

produced to this protocol because if they are not, then they will technically still be classed as waste

3.4 Increased Reinstatement Performance

3.4.1 The batch mixed SMR ECO C2 NFSMR will produce a higher surface modulus than using traditional unbound aggregates e.g. Type 1 803

'A stiffness modulus based on the application of a known load at the top of the foundation; it is a composite value with contributions from the underlying layers'

3.4.2 This will help ensure that long term performance and durability of the utility trench reinstatement and reduce any subsidence and remediation costs. The higher performance stiffness of the material will also allow for good compaction of the asphalt layers on top.

4. Background

4.1 The SMR Eco Proprietary Binder is a cementitious based proprietary Binder who's intellectual property is owned by METSSL Ltd. The SMR Eco Proprietary Binder is used to produce a C2 Non Flowable Structural Material for Reinstatement (C2 NFSMR) as per the Specification for Road Openings in the Roads (SROR) 2003, Appendix A9.1.2.a.iii, and page 112;

iii) Non-flowable SMRs (NFSMRs)

These materials comprise of any type and combination of aggregates and binders. They are non- flowable mixes that will normally require compaction on site, and will be capable of achieving strengths equivalent to FCRs in their compacted state. These materials may only be used on a trial basis by prior agreement

4.2 The purpose of the trial is to verify that the SMR Eco Proprietary Binder used to produce the C2 NFSMR is fit for purpose and has the structural longevity to be used in the relevant layers and depth thickness as detailed in table A9.1 of the SROR 2003. The processes and procedures to produce the C2 NFSMR with the SMR Eco Proprietary Binder are detailed in the WRAP Complaint Quality Protocol produced and supplied by METSSL Ltd to Doocey N.E. Ltd

4.3 Road Type & Layer Usage

4.3.1 The relevant road types, layer depths and thickness as to where a C2 NFSMR can be found in Table A9.1 of Appendix A9 of the SROR 2003 a copy of which can be found below.

Layer	Road Type					Footway Footpath or Cycletrack
	0	1	2	3	4	
Combined Binder Course & Sub-base	NP	NP	NP	NP	NP	150mm C2
Base (Roadbase) Alone	NP	NP	NP	300 mm C2	200 mm C2	---
Base (Roadbase) & Sub-base	NP	450 mm C4	450 mm C4	450 mm C2	350 mm C2	---
Sub-base &/or below	150 mm C2	150 mm C2	150 mm C2	150 mm C2	150 mm C2	100 mm C2

Crushing Strength at 90 days	C4 - 4 N/mm ^{2} Minimum to 10 N/mm ^{2} Maximum C2 - 2 N/mm ^{2} Minimum to 10 N/mm ^{2} Maximum
Note to Table A9.1: NP = Not Permitted ref A9.3.1	

5. Methodology- Proposed Testing & Monitoring

5.1 Initial laboratory testing has been carried out on the SMR Eco proprietary binder by a UKAS accredited laboratory. Results of these tests are detailed in Appendix 1.

5.2 It is also proposed that the following in-situ testing and on-site monitoring is undertaken that a 2 Year sign off visual inspection be undertaken supported by photographic evidence.

6. Sites tested for Trial Sign Off

6.1 Thirteen sites have been detailed in Appendix 3 of this report however the minimum requirement detailed in the SROR 2003 Appendix A9, A9.5.2.1 (2) Scheme for Approved Trials is 2 sites.

Site Location	LA Reference	Road Type	Date Reinstated
Carment Drive, Glasgow	1431601	4	05/04/2013
Glenspean Street, Glasgow	1430702	4	11/04/2013
Beverley Road, Glasgow (jct Calderwood Rd)	1551015	4	03/06/2013
Alloway Road, Glasgow	1439884	4	20/05/2013
Grantley Gardens, Glasgow	1431742	4	24/05/2013
Riverside Road, Glasgow	1513520	3	13/08/2013
Sinclair Drive, Glasgow	1640622	3	25/06/2014
Sinclair Drive, Glasgow	1542361	3	08/11/2013
Edgemont Street, Glasgow	1484431	4	24/07/2013
Bellwood Street, Glasgow	1484692	4	09/08/2013
Underwood Street, Glasgow	1484886	4	09/08/2013
Blairhall Avenue, Glasgow	1484424	4	27/06/2013
Bowman Street, Glasgow	1483395	4	27/08/2013

7. Methods of Production

7.1 In all cases the "**SMR Eco proprietary Binder**" used for reinstatement at these sites was mixed mechanically. The Quality Protocol in each case was based upon the WRAP Protocol for the Production of a C2 NFSMR. A copy of the WRAP protocol can be found in Appendix 2. Appendix 6 to this report also details the SMR Batch Mix End User Method Statement

8. Appendix A9 Trial Criteria – Evaluation

8.1 Training/Assessment & Competency of Personnel

8.1.1 All operatives producing the SMR Eco Batch mixed C2 NFSMR will have been trained by METSSL Ltd and been issued with a certificate stating this. In addition to this all producers of the C2 NFSMR will have the relevant certificates and qualifications to operate the plant and equipment used in the recycling process.

8.2 Control of Raw Materials

8.2.1 Please see Appendix 2 'WRAP Compliant Quality Protocol' (written and produced by METSSL Ltd) Section 3.4 and Appendix 1

8.3 Process Control

8.3.1 Please see Appendix 2 'WRAP Compliant Quality Protocol' Section 3.5, (written and produced by METSSL Ltd) Appendix 1 and Appendix 2.

8.4 Inspection, Testing & Frequencies

8.4.1 Please see Appendix 2 'WRAP Compliant Quality Protocol' Section 3.6.1 and 3.6.2 (written and produced by METSSL Ltd)

8.5 Transport & Delivery

8.5.1 Please see Appendix 2 'WRAP Compliant Quality Protocol' Section 3.5 and Appendix 1. (Written and produced by METSSL Ltd)

8.5.2 The C2 NFSMR will be transported and accompanied by a Delivery Note. This demonstrates the additional information accompanying the C2 NFSMR when it is transported and delivered to site.

8.6 Laying Operation

8.6.1 The C2 NFSMR will be laid and compacted by qualified NRSWA operatives. The layer thickness and compaction rate can be found in Appendix A8 of the SROR 2003

8.7 Audit & Review

8.7.1 Auditing on the Doocey N.E Ltd recycling facility that produces the C2 NFSMR can be seen in Appendix 6 of the 'WRAP Compliant Quality Protocol' as seen in Appendix 2 to this report. (Written and produced by METSSL Ltd)

8.7.2 On-site monitoring will comprise of a visual inspection accompanied by photographic evidence and a 2 year inspection, accompanied by photographic evidence.

8.7.3 Initial testing will comprise of UKAS laboratory testing and on-site Lightweight Deflectometer testing. After 2 years a visual inspection will be carried out to prove that the product has performed as expected.

8.8 Complaints Handling

8.8.1 In regards to the production of the C2 NFSMR any complaints regarding the production of the product will be logged and shared with all relevant parties. In regard to the laying and compacting of the C2 NFSMR, the complaints procedure will be detailed in the utility company's or contractor's working policies and health and safety polices.

8.9 Additional Information

8.9.1 The below information is not detailed in the Appendix A9 assessment criteria however has been added to the trial evaluation:

1. Corrective Actions: Flow Charts that help to assist in evaluating root causes for remedial works potentially encountered in the trial: Product Production, Product Transport, Product Storage, and On-site sinkage – See Appendix 54.
2. Obtaining Maximum Recovery Rates on Utility Waste: Document detailing how potentially the maximum recovery rate can be achieved on utility trench arisings by using binders in the recovery/recycling process and the products that can be produced – See Appendix 5.

9. Verification of Trial Outcomes

9.1 A visual inspection of all the sites detailed in the table below was undertaken by Craig McQueen of Scottish Water and David Murdoch of Glasgow City Council on 05/02/2015.The visual findings of these inspections have been documented in Appendix 3 to this report. An SMR Eco proprietary binder was added at an addition rate of 2% by weight to produce a C2 Non Flowable SMR and was used in the following road categories:

Site Location	LA Reference	Road Type	Date Reinstated
Carment Drive, Glasgow	1431601	4	05/04/2013
Glenspean Street, Glasgow	1430702	4	11/04/2013
Beverley Road, Glasgow (jct Calderwood Rd)	1551015	4	03/06/2013
Alloway Road, Glasgow	1439884	4	20/05/2013
Grantley Gardens, Glasgow	1431742	4	24/05/2013
Riverside Road, Glasgow	1513520	3	13/08/2013
Sinclair Drive, Glasgow	1640622	3	25/06/2014
Sinclair Drive, Glasgow	1542361	3	08/11/2013
Edgemont Street, Glasgow	1484431	4	24/07/2013
Bellwood Street, Glasgow	1484692	4	09/08/2013
Underwood Street, Glasgow	1484886	4	09/08/2013
Blairhall Avenue, Glasgow	1484424	4	27/06/2013
Bowman Street, Glasgow	1483395	4	27/08/2013

9.2 The inspections show that the SMR material is performing well with no failures attributable to the material. Three of the thirteen sites inspected had defects identified

that were related to joint proximity, joint and surface condition, road markings and ironwork. No defects were due to the use of SMR. It should be noted that the winter of 2012 saw severe inclement weather conditions where freezing temperatures and heavy snowfall have been experienced. The winter of 2013 from December onwards also saw unprecedented amounts of rainfall with none of reinstatements displaying failures due to the SMR material.

10. Recommendation

10.1 It is recommended that 'SMR Eco Proprietary binder' is approved as a C2 NFSMR in accordance with Appendix 9 of the SROR (third edition).

11. Signature Page

Signature Page

Council: GLASGOW CITY COUNCIL.

Position in Organisation: Head of Roads.

Print Name: ANDY WADDELL

Signature: A. Waddell.

Date: 9 March 2015.

Utility Company: SCOTTISH WATER

Print Name: MARK MCEWEN

Position in Organisation: GENERAL MANAGER - CUSTOMER SERVICE

Signature:

Date: 9th March 2015.

Proprietary Binder Supplier: METSSL LTD

Print Name: SEB LOVE

Position in Organisation: DIRECTOR

Signature:

Date: 14/11/2014

APPENDICES

Appendix 1: Pre Job UKAS Laboratory Testing

1. Concrete Test Cube report- Day 7 & 28
2. Classifications test for the Constituents of Coarse Recycled Aggregates
3. Determination of Reference Density and Water Content: BS EN 13286-4
4. Determination of the Particle Size Distribution
5. Determination of Reference Density and Water Content: BS EN 13286-4
6. Frost Heave of Recycled Aggregate With 2% SMR Binder Ex. Rutherglen Recycling Centre
7. Determination of the Particle Size Distribution

Scientifics

CONCRETE TEST CUBE REPORT

BS 1881-116:1983 (withdrawn)

139 Summerlee Street
Quarrylee Industrial Estate
Glasgow
G33 4DB
Tel: +44(0) 141 774 6211
Fax: +44(0) 141 774 2111

Report no: GLM5089712.01 Date: 20/06/2012

Client: DOOGEY NORTH EAST LTD Scheme: Quay Road, Rutherglen Contract no: 50164711

Request Sheet No.	Lab Ref.	Client Ref.	Date Made	Time Made	Date Received in Laboratory	Date Tested	Age days	Weight kg	Dimensions mm	Density kg/m³	Failure Load kN	Compressive Strength N/mm²	Specified Strength at 28 days N/mm²
L947	5089712	004/2	18/05/2012		24/05/2012	16/06/2012	28	7.150	150x150x150	2120	87.7	3.9	2.0

Location: Site Trial No.004
Mix details: NFSMR (1.0)

The following apply unless otherwise stated under Remarks.
1) Laboratory curing range 16°-25°C.
2) Cube appearance as received satisfactory.
3) Test moisture condition and density saturated.
4) Cube failure normal. Concrete appearance normal.
5) Volume determined by measurement of designated size. Any loss measured by displacement.
6) Laboratory curing conditions carried out during test checking.
7) Certificate of sampling not received. Certificate of making and curing not received.

Issued to: DOOGEY NORTH EAST LTD

Certified that curing in the laboratory and testing carried out in accordance with BS 1881:111: 114: 116: 1983

Signed: Kenny Morrison - Operations Manager

for and on behalf of Environmental Scientifics Group Limited

Scientifics

CONCRETE TEST CUBE REPORT

BS 1881-116:1983 (withdrawn)

139 Summerlee Street
Quarrylee Industrial Estate
Glasgow
G33 4DB
Tel: +44(0) 141 774 6211
Fax: +44(0) 141 774 2111

Report no: GLM5089711.01 Date: 08/06/2012

Client: DOOGEY NORTH EAST LTD Scheme: Quay Road, Rutherglen Contract no: 50164711

Request Sheet No.	Lab Ref.	Client Ref.	Date Made	Time Made	Date Received in Laboratory	Date Tested	Age days	Weight kg	Dimensions mm	Density kg/m³	Failure Load kN	Compressive Strength N/mm²	Specified Strength at 28 days N/mm²
L947	5089711	004/1	18/05/2012		24/05/2012	25/05/2012	7	6.949	150x150x150	2080	63.7	2.8	2.0

Location: Site Trial No.004
Mix details: NFSMR (1.0)
Remarks: Degree of saturation uncertain

The following apply unless otherwise stated under Remarks.
1) Laboratory curing range 16°-25°C.
2) Cube appearance as received satisfactory.
3) Test moisture condition and density saturated.
4) Cube failure normal. Concrete appearance normal.
5) Volume determined by measurement of designated size. Any loss measured by displacement.
6) Laboratory curing conditions carried out during test checking.
7) Certificate of sampling not received. Certificate of making and curing not received.

Issued to: DOOGEY NORTH EAST LTD

Certified that curing in the laboratory and testing carried out in accordance with BS 1881:111: 114: 116: 1983

Signed: Kenny Morrison - Operations Manager

for and on behalf of Environmental Scientifics Group Limited

Page 1 of 1

ESG Scientifics

TEST REPORT

Classification Test for the Constituents of Coarse Recycled Aggregate

Report No:	**GLM0015536/350/S0**	**Report Date:**	**20 September 2012**
Client	DOOCEY NORTH EAST LTD	Our Contract Ref.	50/54711
Address	BOWESFIELD LANE STOCKTON ON TEES CLEVELAND TS18 3HF GB	Client Order No	PW161-4
		Sample No	5091350
		Client Sample Ref	Not given
		Date Sampled	Not given
		Date Received	11.07.2012
Client Contact	Paul Williams	Date Tested	29.08.2012
Site	Rutherglen Recycling Centre		
Location	Not given		
Description	Recycled Aggregate With 2% SMR Binder		
Material Specification	Not given	Material Supplier	Doocey North East Ltd
Sample Type	Bulk Bag	Material Source	Rutherglen Recycling Centre
		Sampling Cert Received	No
		Samples Submitted by	Client
		Sampled by	Client

Results

Mass of Initial Test Portion (g)		17715.0
Mass of Test Portion (g)		8919.0
Mass Retained 63mm Sieve (g)		0.0
Mass Passing 4mm Sieve (g)		7450.0
Mass of Reduced Non Floating (g)		8919.0
Drying Temperature (°C)		108.7
Proportion of Concrete (%):	**Rc**	15
Proportion of Unbound Aggregate (%):	**Ru**	79
Proportion of Clay Masonry (%):	**Rb**	0.0
Proportion of Bituminous Material (%):	**Ra**	5.6
Proportion of Glass (%):	**Rg**	0.1
Proportion of Other Material (%):	**X**	0.0
Floating Constituent (cm³/kg):	**FL**	0.0

Comments: Sample reduction in accordance with BSEN 932-2 clause 8

Certified that the Classification Test for the Constituents of Coarse Recycled Aggregate was determined in accordance with BS EN 933-11:2009

Signed:

Malcolm Lawson - Section Manager

for and on behalf of Environmental Scientifics Group Limited

Page 1 of 2

BS EN 13242 : 2002 +A1 : 2007 Table 12 - Categories of constituent contents of coarse recycled aggregates

Constituents	Content Percentage by mass	Category
Rc	90	Rc90
	80	Rc80
	70	Rc70
	50	Rc50
	50	Rc Declared
	No requirement	Rc NR
Rc + Ru + Rg	90	Rcug90
	70	Rcug70
	50	Rcug50
	50	Rcug Declared
	No requirement	Rcug NR
Rb	10	Rb10
	30	Rb30
	50	Rb50
	50	Rb Declared
	No requirement	Rb NR
Ra	[illegible]	Ra [illegible]
	No requirement	Ra NR
Rg	2	Rg2
	5	Rg5
	25	Rg25
	No requirement	Rg NR
X	1	X1
	Content cm³/Kg	**Categories**
FL	5	FL5
	10	FL10

BS EN 12620 2002 +A1 : 2008 Table 20 - Categories of constituents of coarse recycled aggregates

Constituents	Content Percentage by mass	Category
Rc	90	Rc90
	80	Rc80
	70	Rc70
	50	Rc50
	50	Rc Declared
	No requirement	Rc NR
Rc + Ru	95	Rcu95
	90	Rcu90
	70	Rcu70
	50	Rcu50
	50	Rcu Declared
	No requirement	Rcu NR
Rb	10	Rb10
	30	Rb30
	50	Rb50
	50	Rb Declared
	No requirement	Rb NR
Ra	1	Ra1
	5	Ra5
	10	Ra10
X + Rg	0.5	XRg0.5
	1	XRg1
	2	XRg2
	Content cm³/kg	
FL	0.2*	FL0.2
	2	FL2
	5	FL5

* The 0.2 category is intended only for special applications requiring high quality surface finish

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Environmental Scientifics Group

UKAS TESTING

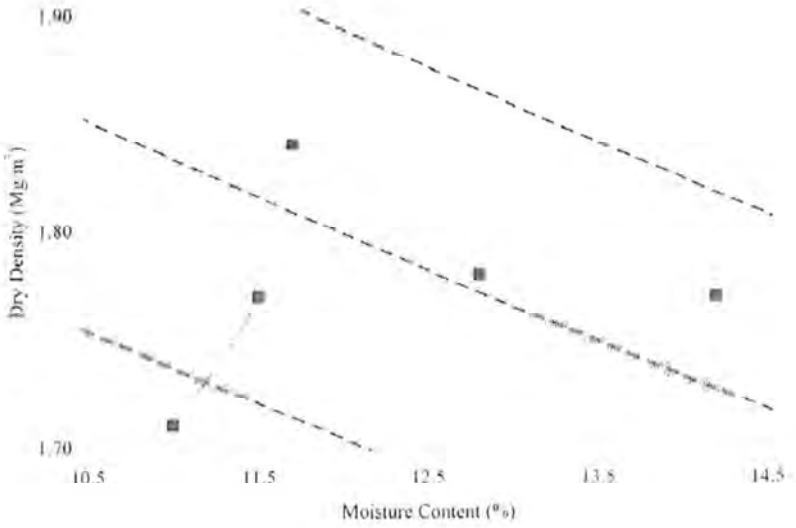
TEST REPORT

Determination of Reference Density and Water Content
BS EN 13286-4

Report No. G17902 M56491 2

Client:	Doocey North East Ltd, Bowesfield Lane, Stockton on Tees, TS18 3HF		
Scheme:	Quay Road, Rutherglen	Laboratory Ref:	M56491 2
Location:	Not Stated	Date Tested:	30-31 05 2011
Client Ref:	A	Date Received:	15 5 12
Material Description:	Blended Type 1 Sub-base Soil with 2% SMR	Date Sampled:	Not Stated
Type of Sample:	Bulk		
Amount retained on:	20mm sieve: 8%	40mm sieve: 0%	
Assumed Particle Density (Mg/cu.m.)	2.45		

As received water content (%):	14
Optimum Water Content (%)	12
Maximum Dry Density (Mg/cu.m.)	1.84



Comments:

Sample Preparation: In accordance with BS EN 13286-4 : 2003,6.3
Certified that the test was carried out in accordance with BS EN 13286-4 : 2003, Method 7

Page 1 of 1

Date Reported: 26 6 12

Signed
Environmental Scientifics Group Ltd

( )K McIntosh
( )M Lawson
(✓)T Geraghty

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TEST REPORT

Determination of the Particle Size Distribution

Sample No	M57349/1	Client Ref	N/S
Report No	G18062/M57349/1		
Client	Doocey North East Ltd, Bowesfield Lane, Stockton on Tees, TS18 3HF		
Contract	Rutherglen Recycling Centre		
Location	Not Stated		
Material	Blended Type 1 Sub-base/Soil with 2% SMR Binder		
		Report Date	09 August 2012
Specification	SHW 2009 Table 6/2	Date Sampled	Not Stated
Source	Rutherglen Recycling Centre	Date Received	11 July 2012
Supplier	Doocey North East Ltd	Date Tested – From	18 July 2012
Sampled by	Client	Date Tested – To	27 July 2012

Test Result

Sieve	Passing %	Specification
63mm	100	100
31.5mm	97	75 – 99
16mm	78	43 – 81#
8mm	58	23 – 66#
4mm	42	12 – 53#
2mm	31	6 – 42#
1mm	21	3 – 32#
63um	2.8	0 – 9

Additional Test Information

Test/Method	Result	Specification
Water Content (%) BSEN 1097-5 1999	13.5	N/A

Remarks:
Supplier declared value grading range not available. Overall grading range values stated.
A sampling certificate is not available
Sample complies with overall grading range values.

Additional Information:

Certified that testing was carried out in accordance with BS EN 933 -1 : 1997

Signed by
Environmental Scientifics Group Ltd

( ) K McIntosh Operations Manager
(✓) T Lawson Section Manager
( ) T Geraghty Senior Technician

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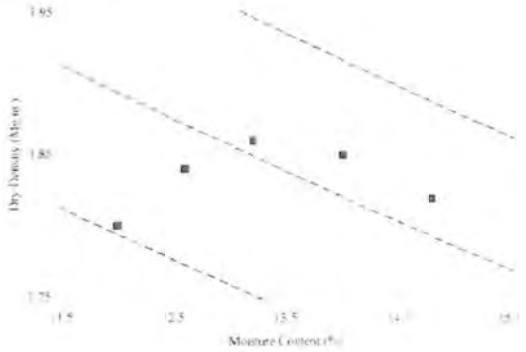
TEST REPORT

Determination of Reference Density and Water Content
BS EN 13286-4

Report No: G18062/M57349/2

Client:	Doocey North East Ltd, Bowesfield Lane, Stockton on Tees, TS18 3HF		
Scheme:	Rutherglen Recycling Centre	Laboratory Ref:	M57349/2
Location:	Stock	Date Tested:	25/26/7/12
Client Ref:	Not Stated	Date Received:	11/7/12
Material Description:	Blended Type 1 Sub-base Soil with 2% SMR Binder		
Type of Sample:	Bulk	Date Sampled:	Not Stated
Amount retained on:	20mm sieve: 15%	40mm sieve: 0%	
Assumed Particle Density (Mg/m.m.):	2.62		

As received water content (%): 14
Optimum Water Content (%) 13
Maximum Dry Density (Mg/m.m.) 1.86



Comments:

Sample Preparation: In accordance with BS EN 13286-4 : 2003 6.3
Certified that the test was carried out in accordance with BS EN 13286-4 : 2003 Method 7

Date Reported: 9/8/12

Signed
Environmental Scientifics Group Ltd

( ) K McIntosh
( ) T Geraghty

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Glasgow G33 4DB

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ESG Environmental Scientifics Group

TEST REPORT

Report No: G18062/M57348
Our Ref: CR/M57348
Date: 31 August 2012

Doocey North East Ltd
Bowesfield Lane
Stockton on Tees
TS18 3HF

Dear Sirs,

FROST HEAVE OF RECYCLED AGGREGATE WITH 2% SMR BINDER EX. RUTHERGLEN RECYCLING CENTRE

1. INTRODUCTION

2. We refer to a bulk sample of Recycled Aggregate with 2% SMR Binder submitted to our Glasgow Laboratory on 11 July 2012

2. MATERIAL AND SOURCE

2.1 Sampling	:	Sample obtained by Client Certificate of Sampling was not submitted
2.2 Reference	:	Not Stated
2.3 Material	:	Recycled Aggregate with 2% SMR Binder
2.4 Designation	:	Not Stated
2.5 Date Sampled	:	Not Stated
2.6 Date Tested	:	13 July – 19 August 2012
2.7 Source	:	Rutherglen Recycling Centre

3. TESTING

3.1 Determination of Frost Heave

4. METHODS

4.1 Tested in accordance with BS 812-124: 2009

Signed By: M Lawson
Environmental Scientifics Group Ltd

( ) K McIntosh, Operations Manager
(✓) M Lawson, Section Manager
( ) T Geraghty Senior Technician

TEST REPORT

Issued By ESG Ltd, Glasgow Laboratory

Report No: G18062/M57348 Date of Issue: 31 August 2012

Client: Doocey North East Ltd

FROST HEAVE OF RECYCLED AGGREGATE WITH 2% SMR BINDER EX. RUTHERGLEN RECYCLING CENTRE

5.2 TEST DATA

5.2.1 SPECIMEN PREPARATION DATA

Optimum Water Content (%)	Maximum Dry Density (Mg/m³)
Not Determined	Not Determined

5.2.2 VALIDITY OF TEST RUN

Parameter	Result (mm)	CRITERIA
Heave of Individual Reference Specimens	11.0 9.5 10.0	
Mean Heave of Reference Specimens	10.2	13.6 ± 4.0mm
Maximum Range in any set of 3 No Test Specimens	1.5	Not to exceed 6mm
CONDITION REQUIREMENTS	**SATISFACTORY**	

5.2.3 FROST HEAVE RESULTS

Sample Reference	Maximum Heave After 96 Hours		CLASSIFICATION
	Individual Specimens (mm)	Mean	
M57348	2.5 2.5 4.0	3.0	**NON-FROST SUSCEPTIBLE**

Comments:

(i) In accordance with the Specification for Highway Works, 2009 Clause 801, the material is classified **NON-FROST SUSCEPTIBLE** if the mean heave is 15mm or less.

(ii) Submitted sample prepared and compacted at Natural Moisture Content with the addition of 2% SMR Binder as supplied by client.

(iii) Specimens were prepared and cured for 28 days in sealed containers in accordance with BS 1924-2:1990.

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Glasgow G33 4DB

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ESG Environmental Scientifics Group

UKAS TESTING

TEST REPORT

Determination of the Particle Size Distribution

Sample No:	M56491/1 Client Ref: A	Report No	G17902/M56491/1
Client:	Doocey North East Ltd, Bowesfield Lane, Stockton on Tees. TS18 3HF		
Contract:	Quay Road, Rutherglen		
Location:	Not Stated		
Material:	Blended Type 1 Sub-base/Soil with 2% SMR		
		Report Date	26 June 2012
Specification:	SHW 2009 Table 6/2	Date Sampled	Not Stated
Source:	Not Stated	Date Received	15 May 2012
Supplier:	Not Stated	Date Tested – From	24 May 2012
Sampled by:	Client	Date Tested – To	08 June 2012

Test Result

Sieve	Passing %	Specification
63mm	100	100
31.5mm	98	75 – 100
16mm	88	43 – 81
8mm	72	23 – 66
4mm	58	12 – 53
2mm	41	6 – 42
1mm	26	3 – 32
63µm	2.2	0 – 9

Additional Test Information		
Test/Method	Result	Specification
Water Content (%)	13.9	
BS EN 1097 – 5: 1999		

Remarks:

A sampling certificate is not available

Additional Information:

Certified that testing was carried out in accordance with BS EN 933 -1 : 1997

Signed by: T. Geraghty
Environmental Scientifics Group Ltd

( ) K McIntosh Operations Manager
( ) M Lawson Section Manager
(✓) T Geraghty Senior Technician

Appendix 2:

WRAP QUALITY PROTOCOL: PRODUCTION CONTROL SYSTEM OF C2 NFSMR

Flow Chart for the acceptance and processing of waste

Factory production protocol

Products provided

Acceptance criteria of incoming waste

Production Method statement

Testing

Record Keeping

Quality Statement

Information supplied by the Producer

Appendix 1: **Full Method Statement of production**

Appendix 2: **Example of a batch document**

Appendix 3: **Waste Acceptance policy**

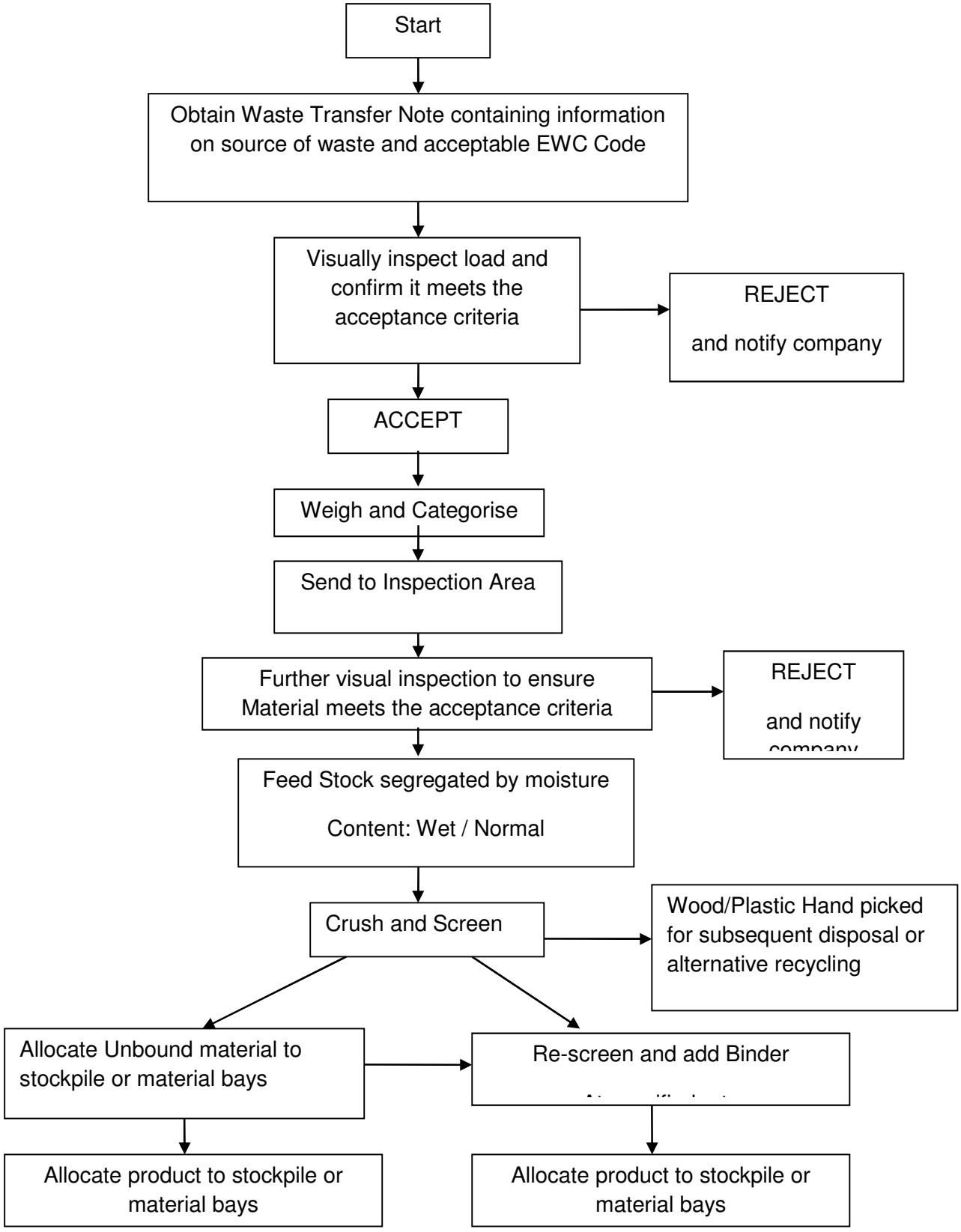
Appendix 4: **Corrective Actions – Constituency Failure**

Appendix 5: **Corrective Actions – Mix design Failure**

Appendix 6: **Example of an Audit to ensure compliance with the Quality protocol**

Appendix 7: C2 NFSMR Mix Designs

Excavated material from various locations will be delivered to the recycling facility, which will have an Environment Agency approved waste management licence or exemption



3.1 Factory Production Control

Responsibility and Authority
1) Recycling manager/Management Representative: Will be responsible for ensuring the requirements of the protocol are implemented and maintained.

2) Site Manager: Responsible for the day-to-day running of each production site.

3) Production operatives: Ensure that the work carried out is to the protocol and are instructed by the site manager.

Internal Audits
These will be carried out by the Recycling Manager, every 6 months. The information will be stored and kept for a minimum of 2 years and will be available to all customers on request.

Management Review
This will be carried out annually or as appropriate with the introduction of new or amendment to existing legislation.

Sub-Contract Services
Any Sub-contract services employed by the company will be expected to adhere to this protocol and will be issued with a copy of this protocol prior to work commencing.

Records
Refer to 3.6, 3.7 and 3.9

Training
All personnel involved in the process will be trained to conform with the protocol and other relevant legislation. Appropriate training records will be kept and maintained. Only suitably qualified personnel will be allocated assigned tasks in the protocol.

Control procedures
Refer to 3.5 and Appendix 1

Composition of mixture, Constituents and process Control
Refer to 3.5 and Appendix 1. Constituency testing can also be found in 3.6.

Inspection and Control of Process Equipment

DEVICE	FREQUENCY	TEST PROVIDER
Clegg Hammer	Annual	Manufacturer

Handling and Delivery
See 3.5 and Appendix 1

Inspection and Testing
See 3.5, 3.6 and Appendix 1

Non Conformity
See 3.4 and Appendix 3

Non-conformity of Mixture
See 3.6.1 daily Production Test.

3.2 & 3.3 Products provided

1. **SMR Batch Mixed:** A <75 mm recycled aggregate with the addition of the proprietary binder called 'SMR Eco', which is supplied by METSSL Ltd. This material will meet the performance requirements laid down in Table A9.1, Appendix A9 of the SROR 2003 for a C2 Non Flowable Structural material for Reinstatement.

3.4 Acceptance Criteria: Incoming Waste

1. Registered Waste carrier enters the recycling facility and submits his waste transfer note that will comply with Level 1 Basic Characterisation as set out in the Landfill Regulations England and Wales 2002, 2004 and 2005 (see appendix 3). Waste should only be accepted from legitimate Registered Waste Carriers.
2. A visual inspection is made on the load to ensure that it matches the waste transfer note and that the correct EWC code has been used to categorise the load.
3. If the material does not match the description on the waste transfer note it is rejected and the company delivering the load notified of this action.
4. The material is then weighed on the weigh bridge and visually categorised by moisture content (Wet or normal). If available a moisture probe should be used
5. The load is then tipped in a 'Inspection Area' where a second visual inspection is made that the waste matches the description on the Waste Transfer Note. If it does not the load is rejected and the company delivering the load notified of this action.
6. The waste transfer note is then stored and kept for a minimum of 2 years.
7. The accepted load will now be taken to the recycling area for processing.
8. A waste acceptance note must be completed in addition to the WTN supplied by the Customer

Only the following European Waste Codes can be accepted:

17.01.01. Clean Concrete
17.01.07. Mixed Concrete, brick, tiles and ceramics, not containing dangerous substances.
17.03.02. Bituminous Material not containing dangerous substances
17.05.04. Inert Soil & Stones, not containing dangerous substances
17.05.08. Track Ballast, not containing dangerous substances

A record of each load delivered and accepted shall be entered on the waste acceptance/delivery note and retained providing the following information:

a) date
b) nature and quality
c) place of origin
d) quantity by weight
e) carrier
f) supplier

3.5 Method Statement of Production

(A full method statement of production can be seen in Appendix 1)

C2 NFSMR

1. The suitable material will initially be pre-screened. Following this:
- Material will be screened to <75mm (to comply with the SROH)
- The material will be screened and shredded and have the SMR additive mixed in.
- Oversize material (75mm>) will be separated form the material and will be crushed to <40mm and be reintroduced to the start of the recycling process.
2. The finished product (<75mm material mixed with the SMR Eco additive) will then be transferred into covered holding bays.
3. The holding bays will display the following information:
- Date of production
- Batch number
- Clegg value of sample taken
4. If the finished product is produced to an NFSMR standard it will be consistent, non-frost susceptible and achieve a minimum compressive strength of 2N/mm2 when air cured for 28 Days.
5. The finished product in the covered holding bays is now ready for dispatch and samples to be taken for testing.

3.6.1 Testing

Product performance compliance testing will be carried out at varied frequencies depending on the test to be conducted. The following Test schedule will be adhered to at all times. Every test batch will also be assigned a batch number to ensure traceability.

Clegg Testing C2 NFSMR Per Production Batch:

1. Select approx. 50 kg of produced material & divide into 2 samples
2. Ensure sample to be tested is representative of the stockpile
3. Carry out drop test, and use material only when it passes the drop test as per the approved method statement.
4. Fill and compact each Test Mould in 3 equal layers.
5. Compact evenly using the compactor tool for 20 seconds on each layer
6. Take a Clegg reading immediately on one of the samples, recording the 4^{th} drop IV. A minimum IV of 19 should be achieved
7. Take another Clegg reading on the other sample 24 hours later, again recording the 4^{th} Drop. The Clegg Value should be noticeably higher than 19IV (at least 24IV).
8. Failure to achieve the required minimum Clegg IV means that the product has failed test and should not be supplied to Customers until the test is successfully repeated and the minimum values achieved.
9. Provided the immediate Clegg IV of 19 is achieved, it is fair to assume the 24 IV will be achieved at 24 hours, therefore, material can be released for supply to Customers.
10. Should the material fail 3 consecutive Clegg Tests, it will need to be returned to the production area for re-processing

C2 NFSMR

Compressive Strength Testing – Per Production Week

(Time Periods relate to production periods not calendar periods)

Compressive strength testing will be carried out by a UKAS accredited laboratory. Four samples will be produced per batch, compacted into a cube mould within 24 hrs of Material Production, and tested at the following time frequencies:

- 1 at 7 days
- 1 at 28 days
- 2 at 90 days

Samples will have the following details recorded: Sample Preparation Date, Due Crush Test Date; Production Batch Number; Name of Production Facility, SMR Eco addition rate.

SMR cubes will be produced and cured as per the SROR 2003 Appendix A9 i.e. 150mm cubes at a 1:1 ratio and cured at 20 degrees centigrade.

3 Monthly testing

In addition to our in-house Factory Production Control & testing regime, the following tests will be carried out 3 monthly by a UKAS accredited laboratory on sampled material:

1) Grading Test: to ensure material is <75mm
2) Aggregate Composition including Organics (SHW Clause 710)

6 Monthly Testing

Frost Heave Susceptibility to BS812 Part 124

3.6.2

It should be noted that the minimum test frequencies suggested in the WRAP Quality protocol for the production of Aggregates from Inert Waste are not applicable to the production of NFSMR Alternative Reinstatement Materials. To ensure compliance with current Streetworks legislation, the testing regime we have adopted for these materials is as set out in Appendix A9 of the 1991 New Roads and Streetworks Act, SROR 2003. All other aspects of the WRAP Quality Protocol are strictly adhered to.

3.7 Record Keeping

The following records will be kept and available to the customer at any point in time upon request:

1. Waste Transfer notes (retained for a minimum of 2 years)
2. Batch data that will include:
    - Batch number
    - Date of Production
    - SMR Eco addition rate to weight of material produced
    - Clegg results of the batch

- CBR results of the relevant test batch
- Compressive strength results of the relevant test batch

3. Actions taken following a batch failure
4. Copy of Waste Management Licence Exemption or Waste Management Licence.
5. Corrective actions taken where constituents or mixture examined have not satisfied the requirements of this protocol. See appendix 4 and 5

3.8 Quality Statement

This Quality Protocol has been written to conform with the WRAP Quality Protocol for the production of aggregates from inert waste.

3.9 Information to be Provided by the producer

When requested by the purchaser, the producer shall provide:

a) test results
b) test procedures
c) outline details of the factory production control manual.

APPENDIX 1: Method Statement of Production

General Instruction

The excavated spoil materials are removed from site by a suitable vehicle, and taken to an EA approved site for processing. The excavated spoil material is received into a designated area at the site pending processing. A qualified Operative shall assess the suitability of the material in accordance with NRSWA 1991 standards, and the appropriate EWC Waste Codes accompanying each load via its Waste Transfer Note. All records produced during this entire process (Including Waste Transfer Notes) shall be retained for a minimum of 2 years for SEEPA and or Local Authority Audit purposes.

If the material is deemed suitable, assessment of soil type (granular, sand or clay), and soil moisture content (dry, wet or very wet), shall be made. Wet materials can be stored and "air dried" to reduce moisture content prior to processing. Organic materials such as peat are not suitable, cannot be used, and must be segregated and stored outside the recycling production area to avoid contamination.

Every effort should be made to ensure the suitable material to be treated is free of contaminants such as wood, plastic and metal, should any be found in excess of 1% by mass or volume (whichever is greater), it must be removed and discarded prior to processing.

Any Plaster (Gypsum etc.) present (regardless of quantity) must be removed and discarded and cannot be included in the material to be treated.

All unsuitable material should be placed in the "Inspection Area" pending Waste Acceptance Criteria testing and ultimate disposal into an appropriate area.

C2 Non Flowable SMR Production

After the waste has been through the Waste Acceptance Criteria it can now be processed in the recycling area.

The material will initially be pre-screened through the 3-way split (or similar) into the following sizes:

- 0/10mm
- 10/50mm
- 50mm+

The 50mm+ material will then be processed through the crusher and crushed to <40mm

To produce a C2 Non Flowable SMR see Appendix 7 which details the size/grades of material will need to be blended together and have the SMR Eco Proprietary Binder added through the batching plant.

After producing the C2 NFSMR allocate the finished product to a sheeted/covered bay for storage. This bay should display the Batch number of the product. Always check the moisture content of the C2NFSMR twice daily, preferably once in the morning and once in the afternoon.

Any NFSMR *with* a manufactured on date older than 7 days must not be dispatched and will be returned to the recycling area for reprocessing.

Always record moisture content, batch number, weather conditions and if the vehicle taking the recycled materials is sheeted on the delivery tickets.

Appendix 2

RECYCLING DEPOT:

C2 NFSMR

Address:

Batch number: ……..

Date of Production:……..

SMR Eco addition rate:……..

Clegg result:

Immediate = ……IV

+24 Hours = ……IV

Compressive strength result:

7 days ……...

28 days ……..

90 days

Appendix 3: Waste Acceptance Policy

ONLY THE FOLLOWING EWC CODES ARE TO BE TIPPED:-

17.01.01. Clean Concrete

17.01.07. Mixed Concrete, brick, tiles and ceramics, not containing dangerous substances

17.03.02. Bituminous Material not containing dangerous substances.

17.05.04. Inert Soil & Stones, not containing dangerous substances

17.05.08. Track Ballast, not containing dangerous substances

Only waste covered by the aforementioned ewc codes can be accepted. waste falling outside of these criteria must be rejected.

All waste tipped must be accompanied by a completed Waste Transfer Note, which must contain the following information:

1. An accurate description of the waste
2. The correct EWC Code
3. The process producing the waste
4. The location at which the waste was produced
5. As from 30/10/07 Pre-treatment Status of the waste
6. Any other information required to comply with your Duty of Care under EA legislation

The site operator reserves the right to reject any waste they consider is, or maybe mis-coded and/or unsuitable for recycling. any mis-coded and/or unsuitable waste tipped by the customer must be removed from the facility within a reasonable timescale and at the customers expense.

Appendix 4: Corrective Actions – Constituents failure

RECYCLING DEPOT

Address:

Constituency failure on waste load

Transport company carrying load:…….

Name of relevant person from the transport company contacted regarding load failure:

……Date:…….

Load rejected:

Date:……. Time:……..

Appendix 5: Corrective Actions - Mixture failure

RECYCLING DEPOT

Address:

(A mixture failure can be identified by achieving an unsatisfactory clegg reading in the 'Clegg Testing per Production Batch 3.6.1)

Clegg Value

Immediate:……..IV

+24 Hours:……..IV

Date:……

Appendix 6: Audit to ensure compliance with the Quality Protocol

Names of Personnel

- Recycling manager/Management Representative:……..
- Site Manager:…….
- Production operatives:…….
- Have the above been certificated? YES/NO
- If no what actions have been taken

……
……
……..

Waste Acceptance

- All Waste Transfer notes present and kept for a minimum of 2 years? YES/NO
- Correct EWC codes used? YES/NO
- Rejected Loads forms present and correctly filled in? YES/NO
- Actions taken and followed up for rejected loads? YES/NO
- If No to any of the above, what corrective action has been taken?.....
  .....
  .....

Method statement

- Do all operatives have access to a method statement? YES/NO
- Are all operatives fully conversant with the method statement? YES/NO
- If No to any of the above, what corrective action has been taken?.....
  .....
  .....

Testing and record Keeping

- Records present and kept for a minimum of 2 years? YES/NO
- Frequencies of testing correct? YES/NO
- Batch documents present containing correct information:
- Batch number? YES/NO
- Production date? YES/NO
- SMR Eco Addition rate? YES/NO
- Clegg testing? YES/NO
- CBR testing? YES/NO
- Compressive strength testing? YES/NO
- PSD/Clause 710/Plasticity YES/NO
- Pass/fail data? YES/NO

- If No to any of the above what corrective actions have been taken?
- ……
  ……
  ……

Load and Batch Failures

- Records kept for a minimum of 2 years? YES/NO
- Correct actions taken? YES/NO
- If No to any of the above, what corrective action has been taken?.....
  .....
  .....

Inspection and Control of Process Equipment

- Has the process equipment been tested at the relevant frequencies laid out in the Quality protocol? YES/NO

- If no, what date has training been arranged for?
- Date: …….

Other

- Is the Waste management Licence, Standard Rules Permit or Exemption readily available and up-to-date?
  YES/NO
- If no, what action has been taken to achieve the relevant Waste management Licence or Exemption?

…….....
.....
.....

Date of Audit:……. Signed:……

Appendix 7: C2 NFSMR Mix Designs

The mix designs are suggested for different time periods throughout the year. Each mix design is intended to be a guide and must be verified by testing undertaken by a UKAS accredited laboratory. If the performance strength is found to be far above 2N/mm2 then the SMR Eco proprietary binder addition can be reduced until a compressive strength of 2N/mm2 at 90 days can safely be achieved.

March to October

Mix Design 01

- 1 part 0/10mm pre-screened material
- 2 parts 10/40mm pre-screened material
- 1 part <40mm crushed
- SMR Eco Proprietary Binder addition of 1.5% to 2%

Mix Design 02

- 2 parts 0/40mm pre-screened material
- 1 part <40mm crushed
- SMR Eco Proprietary Binder addition of 1.5% to 2%

November to February

(Or when the temperature falls below 3 degrees centigrade)

Mix Design 01

- 1 part 0/10mm pre-screened sub-soil fines
- 2 parts 10/40mm pre-screened material
- 1 part <40mm crushed
- SMR Eco Proprietary Binder addition of 1.5% to 2%

Mix Design 02

- 2 parts 10/40mm pre-screened material
- 1 part <40mm Crushed
- SMR Eco Proprietary Binder addition of 1.5% to 2%

Mix Design 03

- 75% Crushed
- 25% 0/10mm pre-screened sub-soil fines
- SMR Eco Proprietary Binder addition of 1.5% to 2%

Appendix 3: 2 Year Sign-Off Report: SMR Eco

This document constitutes a 2 year report as required by the SROR 2003.

'The duration of all approval trials shall be two years; the final inspection being completed within one month following the end of the two-year test period.' SROR 2003, Appendix A9, Page 118

This report consists of a visual inspection of all the sites undertaken by Craig McQueen of Scottish Water and David Murdoch of Glasgow City Council on 05/02/2015.The visual findings of the two year inspections can be seen in the pictures below. An SMR Eco proprietary binder was added at an addition rate of 2% by weight to produce a C2 Non Flowable SMR and was used in the following road categories:

Site Location	LA Reference	Road Type	Date Reinstated
Carment Drive, Glasgow	1431601	4	05/04/2013
Glenspean Street, Glasgow	1430702	4	11/04/2013
Beverley Road, Glasgow (jct Calderwood Rd)	1551015	4	03/06/2013
Alloway Road, Glasgow	1439884	4	20/05/2013
Grantley Gardens, Glasgow	1431742	4	24/05/2013
Riverside Road, Glasgow	1513520	3	13/08/2013
Sinclair Drive, Glasgow	1640622	3	25/06/2014
Sinclair Drive, Glasgow	1542361	3	08/11/2013
Edgemont Street, Glasgow	1484431	4	24/07/2013
Bellwood Street, Glasgow	1484692	4	09/08/2013
Underwood Street, Glasgow	1484886	4	09/08/2013
Blairhall Avenue, Glasgow	1484424	4	27/06/2013
Bowman Street, Glasgow	1483395	4	27/08/2013

Carment Drive, Glasgow- Type 4 Road

Glenspean Street, Glasgow- Type 4 Road

Beverley Rd, Glasgow- Type 4 Road

Alloway Road, Glasgow- Type 4 Road

Grantley Gardens, Glasgow- Type 4 Road

Sinclair Dr, Glasgow- Type 3 Road

Edgemont Street, Glasgow- Type 4 Road

Bellwood Street, Glasgow- Type 4 Road

Underwood Street, Glasgow- Type 4 Road

Blairhall Avenue, Glasgow- Type 4 Road

Bowman Street, Glasgow- Type 4 Road

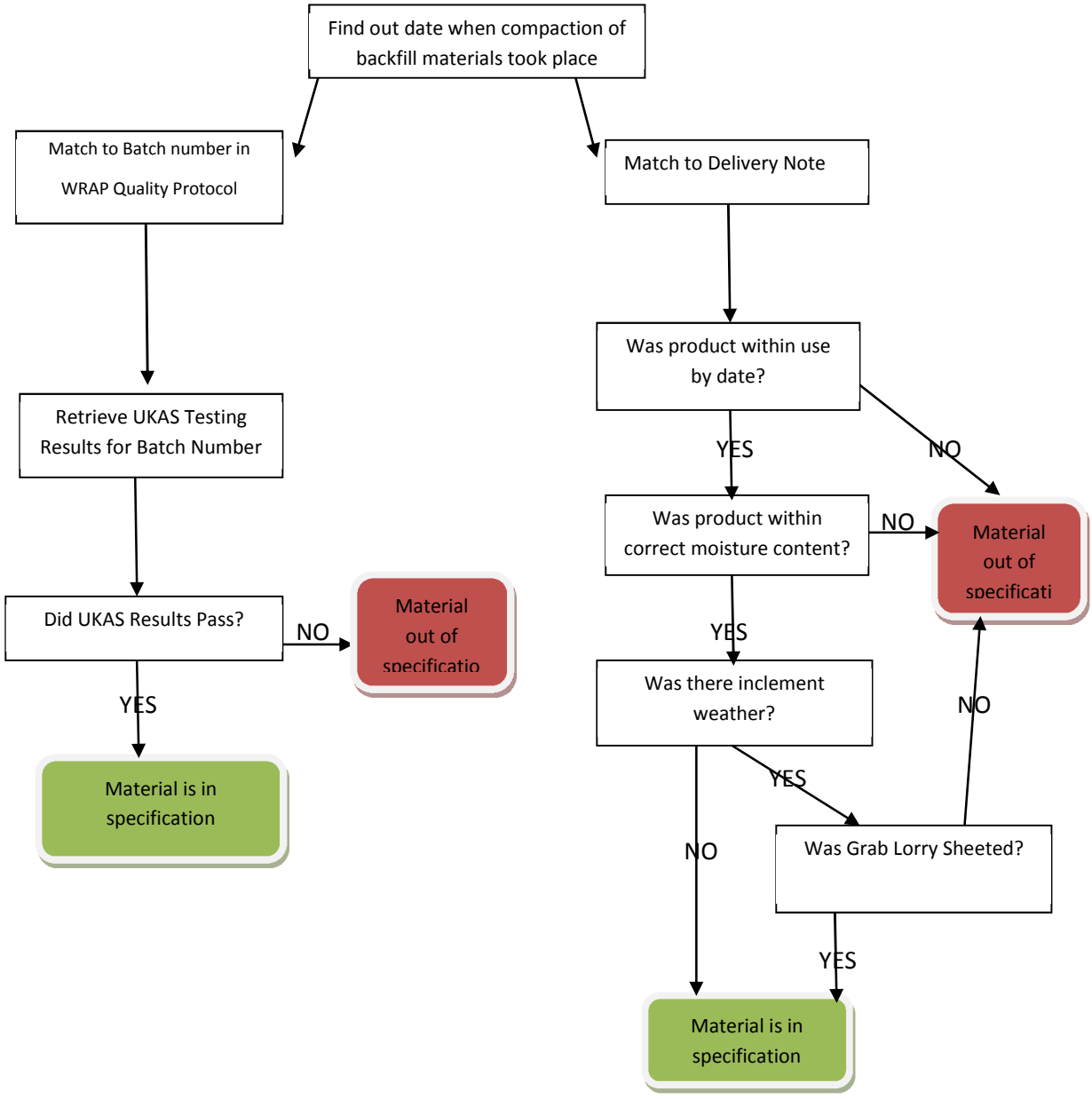
Conclusion:

All locations showed no signs of depressions, heave or any deformation.

The final levels of all the reinstatements were good and all edges were level with the existing carriageway levels. Defects were identified on 3 of the 13 sites inspected however; none of these defects were related to SMR. All issues noted were in relation to the surface course and included 1 proximity failure, 1 failure due to joint condition and surface condition and 1 due to road markings and ironwork. It should be noted that the winter of 2012 saw severe inclement weather conditions where freezing temperatures and heavy snowfall have been experienced. The winter of 2013 from December onwards also saw unprecedented amounts of rainfall.

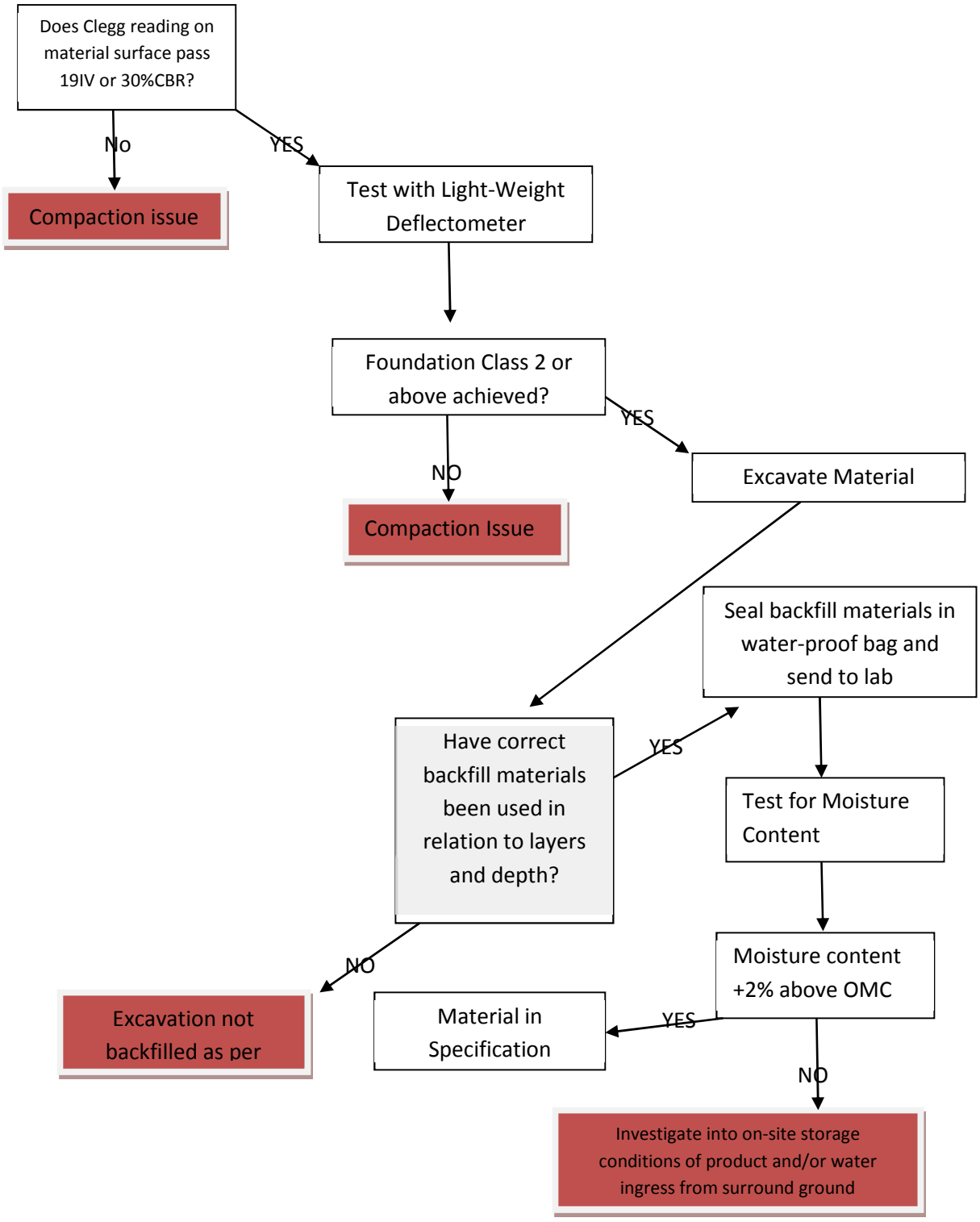
Appendix 4: Corrective Action Flow Charts

Potential Product Issue: Recycling Facility & Transportation



Potential Product Issue: On-Site

(In addition to the below also carry out checks detailed in 'Potential Product Issue: Recycling facility & Transportation' document)

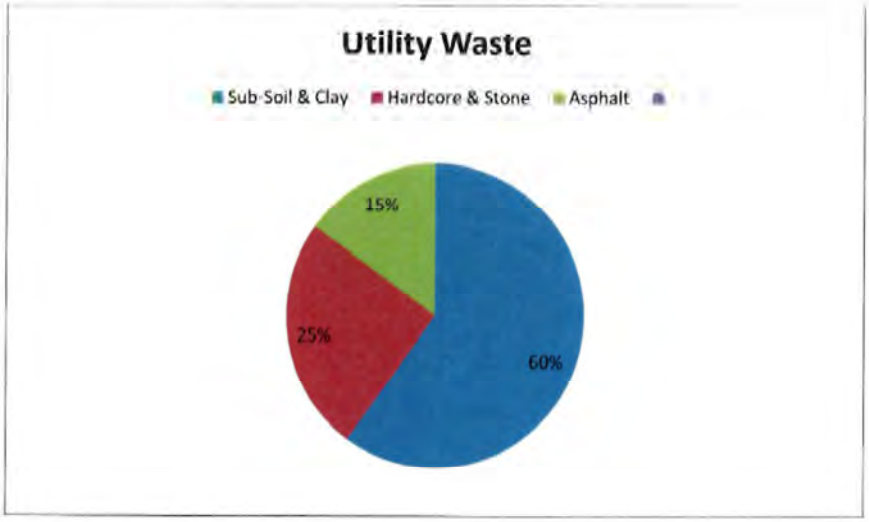


Appendix 5:

Maximising recovery Rates and Sustainability on Utility Waste Arisings

Maximising Recovery Rates & Sustainability on Utility Waste Arisings

Utility waste arisings typically comprise of the following components:



There is currently a big drive in the utility industry to divert as-dug arisings from landfill and re-use them in recycled backfill products. The typical non-flowable recycled backfill products that can be produced from utility waste are as follows:

1. **Recycled Type 1 803:** A 0/63mm graded aggregate that complies with the Specification for Highways Works clause 803.
2. **Non-Flowable Structural Material for Reinstatement (NFSMR)**: A material that includes cementitious or hydraulic binders. A Non-Flowable SMR requires compaction on site and when cured, is required to attain compressive strengths of 1.5/2N/mm2 – 9/12Nmm2. An NFSMR can be used at backfill, sub-base and road base layers. Prior to using an NFSMR, formal Local Authority Approval must be sought by the Statutory Undertaker.
3. **Stabilised Material for Fill (SMF):** Materials derived from excavated spoil, virgin, secondary or recycled materials, or a combination thereof. These materials have been improved by re-grading and re-processing and have an addition of cementitious and/or hydraulic binders. SMF's are normally non-flowable and will require compaction. An SMF can only be used at backfill and sub-base layers, it cannot be used at road base layers. Prior to using an SMF, formal Local Authority Approval must be sought by the Statutory Undertaker.
4. **Hydraulically Bound Mixtures:** Hydraulically bound mixtures (HBMs) are mixtures that set and harden by hydraulic reaction. They include:

• Cement bound materials (i.e. mixtures based on the fast setting and hardening characteristics of cement), and

• slow setting and hardening mixtures made from industrial by products such as fly ash (FA) and ground granulated blast furnace slag (GGBS).

These materials comprise any HBM specified in BSEN 14227- 1, -2, -3, -5, -10, -11, -12, -13 & -14, and shall be produced, handled, transported, used and tested in accordance with the SHW 600 series. Although not called up in the SHW, the HBM types, SBM B4, FABM 4 and HRBBM 4 from BSEN14227-2, -3, & -5 respectively are also included since they are purposely suited for trench reinstatement work. HBMs therefore should be produced, constructed and tested in accordance with the SHW 600 series as if they were SBM B4, FABM 4 and HRBBM 4 respectively. Layer thickness and compressive strength requirements shall be in accordance with Table A9.1 except that the specified compressive strength requirement shall be deemed to apply at 28 days or greater in accordance with, and by the use of, [illegible]

Relevant Layer Usage

SMF: At any position within the surround to apparatus, backfill and sub-base layer

NFSMR and Hydraulically Bound Mixtures: Can be used as per the relevant layers and performance strengths detailed in Table A9.1 of the SROH 2010 3rd Edition:

Table A9.1 – SMR Minimum Layer Thickness and Compressive Strength Requirements

Layer	Road Type					Footway Footpath or Cycle Track
	0	1	2	3	4	
Combined Binder Course & Sub-base	NP	NP	NP	NP	NP	150mm C 1.5/2
Base	NP	NP	NP	300 mm C 1.5/2	200 mm C 1.5/2	—
Base & Sub-base	NP	450 mm C40/4	450 mm C40/4	450 mm C 1.5/2	350 mm C 1.5/2	—
Sub-base &/or below	150 mm C 1.5/2	150 mm C 1.5/2	150 mm C 1.5/2	150 mm C 1.5/2	150 mm C 1.5/2	100 mm C 1.5/2
Crushing Strength at 28 days	C3/4 Minimum to C 9/12 Maximum C 1.5/2 Minimum to C9/12 Maximum					

Note to Table A9.1: NP – Not Permitted (see A9.3.1)

Recovery Rates

NFSMR: The typical recovery rate for an NFSMR is 80% to 100%. Utility spoil will be processed by screening, crushing and the addition of an NFSMR. The benefit of the NFSMR is that it will transform [illegible]

SMF: Recovery rates for an SMF can also achieve 100%. Utility spoil will be processed by screening and grading and then the SMF is blended into the spoil at a prescribed rate. If there is a Crusher on site, oversize material can be crushed and re-introduced into the final product. Again the SMF will be able to dry out what was an unusable material e.g. clay, changing it into a compactable state.

It should be noted that SMF's can also be manufactured in accordance with the SHW clause 840 or BS EN 14227-11. These do not require a trial but can still only be used at the layers in the roads and footpath that are stated above.

Hydraulically Bound Mixture: HBMs' require a durability test called a Loss of Strength Test. To pass this test generally 80%+ of crushed material is required back into the product. The percentage of crushed material can be reduced but to compensate for this the amount of binder added to the product will need to be increased which will push up the price of the product. The recovery rate on HBMs' produced from utility waste therefore is typically around 80% as utility waste typically comprises of the following:

- 60% subsoil and clay
- 30% hard core
- 10% asphalt

Recycled Type 1 803: Traditional Recycling centres producing a recycled type 1 803 will typically recover 40% - 50% of the utility spoil it receives. The spoil will be screened and all the oversize material and hard core will be removed to be crushed and graded to produce a recycled type1 803. The residual waste of the process which can be up to 60%, will normally comprise of soils, clays and fines will have to landfill.

A report by Morgan Est (now Morgan Sindall) on the West Midlands Gas Alliance states how they increased their recovery rates from using Recycled Type 1 803 to using an SMF and/or NFSMR produced with the proprietary binder manufactured by SMR Ltd:

'Due to future increases in landfill tax, lack of landfill sites and consumer/ public interest in environmental concerns, I would recommend the use of SMF/ SMR. We could potentially recycle 100% of our site spoil by using a soil stabiliser, without it only around 45% can be reused. This method also helps towards our target to reduce waste'.

Proposed Product Combination to Maximise on Recovery Rates & Sustainability

The above products could be used in the following road types and road layers to maximise on diverting utility waste arisings from landfill, reducing the carbon footprint, maximising on re-using utility waste in suitable products, reducing overall reinstatement costs and increasing overall maintenance performance:

Type 1 & 2 Roads: Traditional methods

Foam Concrete: Typically a C4 Foam Concrete is used in a Type 1 or 2 road so that the asphalt thickness can be reduced to 100mm. Foam Concrete is also self levelling and fast to use. The downsides to the product are:

- It is generally made from primary materials which are expensive, do not allow waste the re-use of waste arisings and have a high carbon footprint.
- A high cement content is used to produce the product which again is not carbon efficient and not sustainable
- Foam concrete is generally expensive at circa £60 per cubic meter.

Type 1 803: If the Type 1 803 is recycled then typically a 40% recovery rate can be gained from utility waste. The Type 1 803 though can only be used at the sub-base layer and therefore benefits from reduction in asphalt thickness cannot be gained.

Type 1 & 2 Roads: Proposed alternative

The use of a C8/4 HRM could be produced from utility waste arisings using the excavated asphalt, hardcore and approximately 30% of the soil split. The C8/4 HRM would therefore allow a higher recovery rate on utility waste than Foam Concrete and primary Type 1 803. The C8/4 HRM would also allow it to be used at the base layer in a Type 1 & 2 road and therefore reduce the asphalt depth to 100mm

Type 3 & 4 roads

Traditionally Type 1 803 is used as the backfill, sub-base and base layers in these road types. The recovery rate however to produce a Recycled Type 1 803 from utility waste though is approximately 40% to 45%. By using a C1.5/2 NFSMR the recovery rates on utility waste could be increased to 80%+. The C1.5/2 NFSMR can also be used at the same layers as a Type 1 803 material but in terms of performance strength/stiffness is structurally superior therefore safe guarding the longevity of the road.

A C1.5/2 NFSMR could also be used as a replacement to Type 1 803 in Class 1 and 2 roads at the backfill and sub-base layers.

Footpath

Again typically a Type 1 803 is used at the backfill and sub-base layers. A C1.5/2 NFSMR could be used as an alternative giving all the benefits detailed above for Type 3 & 4 roads compared to the use of Type 1 803. The additional benefit that a C1.5/2 NFSMR can give in the footpath over Type 1 803 is that it can be used as a replacement for binder course, therefore reducing the asphalt thickness, increasing sustainability, increasing recovery rates on utility waste and reducing cost.

Surround to Apparatus

Traditionally primary sands, 10/4mm shingle or their recycled alternatives are used as the surround to apparatus. These are typically expensive and generally cost more per tonne than sub-base materials. Utility companies are therefore promoting the use of Selected Excavated Materials (SEM's) as the surround to apparatus and sub-base layers. This is good and increases re-use of materials on-site but depending on the class of SEM also then depends on the depth of Sub-Base that is required (please see Figure A3.5 from the SROH 2010 3rd Edition). Utility companies and contractors will typically use the sub-soil based material as the surround to apparatus and backfill layers but this then incurs an increase thickness of Sub-Base material e.g. using a Class D material requires 300mm of sub-base and using a class C material requires 250mm of Sub-base. It is important that this is followed as if the correct depth of sub-base is not put on top of Class C and D backfill materials then this may not provide adequate structural support for the above road layers and may encounter frost heave problems in the winter months.

It is therefore suggested that the sub-soil/clay fines element of utility waste could be recycled into a Class A SMF. This would then allow the sub-soil/clay element of the utility waste to be re-used as a Class A backfill material and only require 150mm of sub-base on top.

Summary to Achieve Maximised Sustainability on Utility Waste

Road Type	Road Layer	Product
1 & 2	Base	C3/4HBM or C3/4 NFSMR
	Sub-Base	C3/4HBM or C3/4 NFSMR
	Backfill	C3/4HBM or C3/4 NFSMR or Class A SMF
	Surround to Apparatus	C3/4HBM or C3/4 NFSMR or Class A SMF
3 & 4	Base	C1.5/2 NFSMR
	Sub-Base	C1.5/2 NFSMR
	Backfill	C1.5/2 NFSMR or Class A SMF
	Surround to Apparatus	C1.5/2 NFSMR or Class A SMF
Footpath	Binder Course	C1.5/2 NFSMR
	Sub-Base	C1.5/2 NFSMR
	Backfill	C1.5/2 NFSMR or Class A SMF
	Surround to Apparatus	C1.5/2 NFSMR or Class A SMF

Appendix 6:
C2 NFSMR BATCH-MIX:
End User Method Statement

This method statement explains the correct procedure for the storage and use of *SMR Batch-Mix* from excavated spoil for use in footway and carriageway reinstatements. All operatives using *SMR Batch-Mix* within reinstatements will be fully NRSWA compliant.

General Instruction

The work shall be signed and guarded in strict accordance with the Chapter 8 standard or as specified by the relevant Highways Authority. Excavations will be conducted in accordance with applicable Health and Safety Guidelines. A suitably qualified Operative (certified by the SMR Batch-Mix manufacturer), shall ensure the following – See Inspection Criteria –1 & 3

The As Dug Spoil materials are removed from site by a suitable vehicle, and taken to an Environment Agency approved depot for processing into *SMR BATCH-MIX.* This production process is covered via a separate Method Statement of Production and Quality Protocol.

When collecting or receiving material from the *Authorised SMR Batch-Mix Dealer,* it is good practice to protect the material from inclement weather conditions, otherwise the material may become too wet or dry for use.

Always carry out a drop test on the finished *SMR Batch-Mix* material prior to accepting delivery. Any material that fails the drop test must be rejected and returned un-used.

The mixed material will remain useable for up to 7 days (A workability Period test can be carried out to verify this), should be stored in a clearly defined area to prevent contamination, and be protected from inclement weather conditions during storage – see Inspection Criteria 4.

During storage care should be taken to prevent segregation of the *SMR Batch-Mix*. It is good practice to turn over material stock in the bay prior to removal and loading onto a delivery vehicle.

It is good practice that delivery vehicles have facility to protect the *SMR Batch-Mix* from inclement weather during transit and whilst on site. Operatives must use their best efforts to ensure the material remains in a compactable condition prior to use.

On-Site Control Procedure

Prior to placement of the *SMR Batch-Mix* within the reinstatement, a *Drop Test* shall be conducted – see Inspection Criteria – 5.

Upon achieving a successful drop test, the *SMR Batch-Mix* is ready for use – see Inspection Criteria – 6.

Any Material failing to pass the drop test must be rejected and returned, un-used, for reprocessing at the *Authorised SMR Batch-Mix Dealer* location.

The *SMR Batch-Mix* material must be compacted in layers in accordance with NRSWA 1991, Appendix A8: Layer thickness 150mm x 8 passes per layer using only approved compaction equipment – e.g. Min 50 Kg Vibratory Tamper.

Care shall be taken to ensure the proper cavity below road surface is maintained to allow for the required depth of binder and wearing courses specified in Appendix A 7.1 of HAUC Specification, see Inspection Criteria – 8

On-Site Testing

It is good practice to identify that the SMR Batch-Mix material has adequate load bearing to support the application of the wearing course. This can be carried out using a Clegg Impact Soil Tester. A successfully compacted excavation will achieve a minimum Clegg Hammer reading of 19 I.V. upon the 4th drop. Where these values are not achieved, more cure time shall be allowed. Under no circumstances can an excavation be permanently reinstated until the above target test values have been met or exceeded. These confirm that adequate load bearing strength to facilitate correct compaction of the wearing course has been achieved.

**It is noted that it may be impractical to test every job site.*

NO	INSPECTION CRITERIA	QUALITY FORM
1	Signing and barriers shall be maintained in strict accordance with NRSWA 1991. Operatives shall wear practical clothing and personal protective equipment as necessary. Care shall be taken to ensure a cable detection survey is conducted prior to excavation in accordance with any applicable Risk Assessment or Method Statement. The qualified Site Operative shall ensure all critical cable location equipment is calibrate and working properly.	Chapter 8
2	The minimum standard of qualification to access the suitability of the *SMR BATCH-MIX* shall be an Operative qualified to the NRSWA Standard 1991 who holds a current training certificate issued by issued by SMR Ltd or their appropriate SMR Batch-Mix manufacturer. A copy of the Certification shall be held as part of the Operatives Training Record maintained at the Company's office.	HAUC Spec & SMR Training Certificate
3	A hand full of *SMR BATCH-MIX* material is squeezed into a ball. If the material does not remain as a ball when laid flat on the palm of the operatives hand then more moisture is required in the material. The ball is dropped from waist height on to the road surface. The ball should break into several pieces. If the ball remains solid more cure time is required. Under no circumstances shall the treated mix be utilised in the reinstatement until the drop test is successful.	Visual
4	Repeat activities described in Inspection Criteria – 3. The mixed material must pass the drop test immediately prior to use. If a pass cannot be achieved the material must be rejected.	Visual
5	Bedding and pipe surround materials shall conform to HAUC 1991. Compaction of these materials shall be conducted in accordance with Appendix A8 of said Document.	NRSWA HAUC Spec
6	The thickness of lifts and required number of passes shall conform to the NRSWA 1991 Standard Appendix 8. The	HAUC

	qualified Operative shall ensure all mechanical compaction equipment is suitable and meets the NRSWA Criteria. Successfully compacted excavation will achieve a minimum Clegg Hammer reading of 19 I.V. upon the 4th drop. Where these values are not achieved, more cure time shall be allowed.	QFB

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